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ABSTRACT

Gifted students in grades 6-8 were divided into two experimental groups, one receiving traditional creative problem-solving training and the other receiving creative problem-solving with transfer strategies infused; there was also a control group receiving training in various memory tasks, analogical skills, and logic exercises. After the training, the 82 students were given a problem-solving task and were interviewed. The transfer training group exhibited the highest percentage of students applying the strategies, followed by the traditional problem-solving group, and finally the control group. No significant differences were found among the groups on measures of the solutions' fluency, flexibility, originality, and elaboration. Results indicated that there was a higher degree of transfer of problem-solving strategies by the transfer training group, but the creative quality of the responses of the experimental groups was no better than that of the control group. (JDD)

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An Investigaton of the Application of Training in Creative Problem Solving to Content Area Problems

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Abstract

This study investigated whether students trained in Creative Problem Solving (CPS) generalize such training to the solution of problems presented out of the context of the training sessions, and whether their solutions are more creative than those of a control group. In an attempt to answer these questions, 82 sixth, seventh, and eighth grade gifted students were randomly assigned to either of two experimental groups or a control group. The experimental groups were CPS, who received traditional Creative Problem Solving training, and CPST, who received CPS training with transfer strategies infused. The control group received training in various memory tasks, analogical skills, and logic exercises. After the training, all students were given a problem solving task during which they were observed, and a followup interview. Percentages of students in each group who exhibited various problem-solving behaviors were calculated and the results were analyzed using a Chi-square procedure. In each case, the transfer training group had the highest percentage of students applying the strategies, followed by the CPS group, and finally the control group ($p<.05$). An analysis of variance procedure was then used to determine whether differences existed among the mean scores of the three groups on the measures of fluency, flexibility, originality, and elaboration. No significant differences among the groups were found. The results indicate that there was a higher degree of transfer of problem-solving strategies by the CPST group. However, the creative quality of the responses of the experimental groups was no better than that of the control group. It is theorized that the problem solving task make have had a "creative ceiling" that limited the quantity and quality of the responses.

An investigation of the application of training in
Creative Problem Solving to content area problems

The rationale used in many content area curricula for teaching a process approach is that students can be trained to use general strategies that will help them solve problems (Gagne', 1985). It is the assertion of those involved in originating and promoting one such strategy, Creative Problem Solving, that CPS is a way of teaching people to approach and solve problems more effectively (Maker, 1982). Accordingly, a stated goal of CPS training and a similar program, Future Problem Solving (FPS), which applies the same basic process to problems of the future, is to prepare a populace better able to solve the problems of our increasingly complex world (Crabbe, 1982; Torrance and Torrance, 1978).

There is, in fact, research to substantiate that training in CPS can significantly increase the quantity and quality of responses on creativity tasks (Maker, 1982). It is on the basis of such evidence that CPS and FPS are widely promoted, from the annual Creative Problem Solving Institute in Buffalo, NY., to classes in CPS in Gifted Education programs, and an international Future Problem Solving Bowl held yearly (Crabbe, 1982).

However, if training in CPS is to effectively change problem solving behavior, those so trained must apply the process to problems presented out of the context of CPS training. To date there is a dearth of research to show to what degree the process is generalized beyond the training situation. A pilot study (Cramond, Shaw, & Martin,1987) was undertaken to investigate whether students trained in Creative Problem Solving would generalize such training to the solution of appropriate subject area problems presented out of the context of the training sessions. Results of the study indicated that students who participated in traditional CPS training, and were thus not explicitly trained to transfer their CPS skills

from the training environment, performed no better on problem tasks than students in the control group. Students did not give any clear indication from their behavior while solving the problems, nor during the individual interviews, that they applied CPS when appropriate. Most of the students appeared to be unaware of, or unable to verbalize, the methods they used for problem solving.

The danger of assuming that transfer of trained skills will automatically occur has been warned against by researchers such as Perkins (1987), Brown (1980), Gagne' (1985) and others. They make the point that unless training includes some specific steps to ensure generalization of the skill, it is unlikely that it will spontaneously happen.

Salomon and Perkins have identified two mechanisms as necessary for transfer: "high-road" transfer and "low-road" transfer (cited in Perkins, 1987). High-road transfer requires conscious abstraction of an idea and application to a problem in a context which does not obviously resemble the problems used in training, mindful decontextualization. For instance, a student trained to recognize propaganda devices in commercials would also make a conscious application of the same techniques to structure a letter to the editor in an attempt to shape readers' opinions. Low-road transfer, in contrast, is automatically triggered when a similar problem is encountered. A student trained to recognize propaganda techniques in print media may then use the same strategies to understand the same techniques applied in television. Both types of transfer can be facilitated concurrently by teaching self-monitoring of one's problem solving process and deliberate abstraction across contexts for high-road transfer, and providing a variety of practice problems for low-road transfer.

Brown, Campione, and Day (1981) differentiated between "blind training" and "informed training" as to their respective effectiveness in abetting transfer of training. Blind training teaches strategies without

information on when or why to use them. Informed training is more effective because in addition to the training of the strategies, students are assisted to understand why the strategies are helpful and when they might be used. Even more important for transfer is informed training plus self-control which has students practice strategies and monitor their effects (Brown & Campione, 1986).

Bransford, Sherwood, Vye, and Rieser (1987) have concurred that transfer is enhanced when the training situation includes information about the conditions and constraints of the use of the new knowledge. In addition, they have emphasized that this knowledge will be more easily accessed in a novel situation if it is organized and encoded with information that specifies its applicability. Therefore, it is imperative that training in problem solving include differentiation among problem types in order to choose those for which the trained process is appropriate (Bransford, Sherwood, Vye, & Rieser, 1987).

Another important aspect of training that impacts transfer is the content of the training problems. When the content of the problems is relevant to the students, they are more likely to see the applicability of the process and refer to it when similar situations arise in everyday life (Bransford, Sherwood, Vye, & Rieser, 1987). Sternberg (1987) has argued that many of the problems used in training situations are not ones that will help students solve problems in the real world, therefore, having students recognize, define, and solve problems from their own experiences during problem solving training is an effective way to enhance transfer. Students solving their own problems are more likely to care about the outcome and to have the prerequisite background knowledge before beginning the problem solving process.

Evidence of specific techniques that have effectively promoted transfer are found in *The productive thinking program* (Covington, Crutchfield, & Davies, 1966). Skills taught and applied to solve problems

in the program were transferred outside the training environment to solve some very different problems (Olton and Crutchfield, 1969). The program's success may be attributed, in part, to the emphasis placed on teaching skills that enhance transfer: generalization, discrimination, proceduralization, and composition (Gagne', 1985).

The current study was thus modified from the pilot study to include a transfer training component. We still wanted to investigate whether students trained in Creative Problem Solving would generalize such training to the solution of appropriate subject area problems presented out of the context of the training sessions. This time we also attempted to determine if the strategies recommended to facilitate transfer would be an effective aid to the CPS training. In addition, we sought to determine whether children trained in CPS would generate more creative solutions to real-life problems than a similar group of children who had received no training in CPS.

Method

Subjects

Eighty-two sixth, seventh, and eighth grade students who were identified by their school district as gifted participated in the study. Stratified random sampling with respect to grade level and sex was used to assign subjects to either of two experimental groups or a control group. The experimental groups were CPS, who received traditional Creative Problem Solving training, and CPST, who received CPS training with the transfer strategies infused.

Design and Procedures

Subjects in each group met independently with an experimenter for forty minute sessions held twice a week for eight weeks. The CPS group

received blind training in Creative Problem Solving by an experimenter who has been instructed in CPS and who used commercial materials designed to train students in Creative Problem Solving and Future Problem Solving. The training focused on defining a specific problem from a fuzzy situation, brainstorming possible solutions, brainstorming criteria, evaluating solutions with the criteria, and choosing the best solution. Another experimenter trained the control group in various memory tasks, analogical skills, and logic exercises.

The CPST group received the same basic training as the CPS group, but also participated in activities specifically designed to facilitate transfer. An attempt was made to facilitate both high and low road transfer by teaching students to monitor themselves during problem solving, and by using a variety of problems as examples and nonexamples. They were given some perceptual training in differentiating the kinds of problems best attacked through CPS by working with mixed problems in exercises where they had to decide on a strategy to solve each problem. Some logic problems were included and students were encouraged to use processes other than CPS, such as charting or drawing, to find the solution. These activities were part of the informed training in that there were frequent discussions about the benefits and applicability of the CPS process. In addition, the students were encouraged to suggest fuzzy situations from which problems were gleaned. These procedures were used to enhance students' pattern recognition for problems requiring CPS, and thereby increase the chances that they would generalize or discriminate when appropriate.

In order to help the CPST group proceduralize Creative Problem Solving, they were given memory support in the forms of charts and handouts that listed the logical step-by-step process. These were gradually phased out as the training progressed. Both experimental groups were given practice and immediate feedback to aid composition

of the process, but the CPST group was also given the opportunities to decide which problem solving process to use while the CPS group only worked with problems that were appropriate for CPS.

In an attempt to ensure that training would be as similar to the testing situation as possible, both trainers of the CPS group and the CPST group alternated among large group, small group, and individual activities. This was done because CPS is typically taught as a group activity and testing was to be done individually. The individual work also allowed the trainers to check for mastery and give individualized feedback.

Following training, the groups were given problems to solve by two more experimenters who did not know the group assignments of the children. The problem tasks were composed of three open-ended content area problems that could appropriately be attacked using CPS and three problems for which CPS was not appropriate. While students completed the tasks, experimenters used structured observation sheets to observe them for signs of the use of CPS such as listing alternatives, use of criteria on a grid, or any other possible indicators. Each student was then individually interviewed by one of the latter experimenters to provide a second check in determining the procedures used to solve the test problems. None of the interview questions directly mentioned CPS, but were designed to elicit responses indicating whether the student used any part of the CPS process. Finally, test responses were evaluated to determine whether students trained in CPS gave quantitatively or qualitatively different responses to the problems than did their untrained peers. Answers were scored according to the dimensions of fluency, flexibility, originality, elaboration, and total score as used on the Torrance Tests of Creative Thinking (Torrance, 1966).

Results

The first question we sought to answer was whether or not transfer of CPS procedures would occur outside the training environment. To answer this question, individual test protocols were examined for evidence of the application of CPS strategies, structured observations were made during testing, and interviews were conducted following testing. Percentages of students in each group who exhibited various problem-solving behaviors were calculated and were analyzed using a Chi-square procedure.

Analyses indicated that statistically significant differences among the groups existed with respect to their application of criteria selection grids ($X^2(2, N=75) = 7.873, p < .05$), their use of multiple criteria in judging possible solutions ($X^2(2, N=75) = 12.533, p < .05$), and their use of drawing to aid in the solution of problems ($X^2(2, N=75) = 11.632, p < .05$) (See Tables 1-3). In each case, the transfer training group had the highest percentage of students applying the strategies, followed by the CPS group, and finally the control group. Percentages of subjects using each of these strategies are shown in Figure 1.

The second question asked whether training would have an effect on the quality of solutions provided by the students. Students' solutions were evaluated for fluency, flexibility, originality, elaboration, and total score. An analysis of variance procedure was then used to determine whether differences existed among the mean scores of the three groups on the various measures. No significant differences among the groups were found.

Discussion

The results indicate that there was a higher degree of transfer of problem-solving strategies by the CPST group. This would suggest that

the training directed at transfer was more effective than simple CPS training in getting students to use the strategies outside of actual training activities. However, the percentages of students applying the techniques were less than would be expected. Slightly more than one-fourth of the CPST students actually used a selection grid with the same percentage of CPS students using multiple criteria. Approximately half of the CPST students indicated that they used multiple criteria in determining a best solution. A classroom teacher would hope for more application following eight weeks of training. Additionally, there were no differences among the groups in the quantity or quality of the students' solutions.

Why was there differential application of the strategies and not difference in the quality of the products? Why was the application of the strategies so sparse? The quick answers are that CPS does not aid significantly in the solution of problems, and the procedure is an artificial process that students will not actually apply to any great extent outside the training situation. However, CPS has been shown to be effective in improving students' problem solving behavior (Maker, 1982). Perhaps the benefits of CPS are significantly lowered when it is not used in a group situation. Creative Problem Solving was designed as a group problem solving process and most of the training and research involving CPS has been in group situations.

Another plausible explanation is that the problem solving tasks presented to the students were not appropriate for CPS. Interviews conducted during the pilot study indicated that students had difficulty with the post test problems because they did not have sufficient background knowledge to respond to the tasks. To correct for this, we made sure the problems in the present study dealt with situations with which the students were familiar. The problems may have been too familiar.

The possibility exists that we experienced a creative ceiling effect with the problems; where the solutions were so evident that they precluded

dealing with the problem situation creatively. Efficient, effective problem-solvers do not reinvent solutions for problems that they have successfully solved in the past. They simply use the solutions that have worked before. For example, the successful problem-solver, having once figured out how to get a kite out of a tree, will try that solution first and will continue to use that solution until it fails. This notion is supported by responses to one of the questionnaire items: "How did you select the best answer?" Many students said that they had used the solution before and it had worked.

Paul (1984) stated that one of the major weakness of investigations of the problem solving process is their failure to recognize the differences between problems that are technical or procedural in nature and those that are truly dialectical and require the playing with ideas and the point and counter point of argument to solve. Clearly, this second type of problem is more appropriate for strategies such as CPS. Problems that are primarily procedural simply will not lend themselves to a large variety of possible solutions and creative outcomes.

To pursue this possibility, we intend to followup with problems of a more novel nature; ones that are more appropriate for CPS application. Results from this study should help to determine whether or not there was a creative ceiling effect at work due to the nature of the problem-solving tasks.

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Figure 1

Percentage of Students Using Problem-Solving Techniques in Each of the Treatment Groups

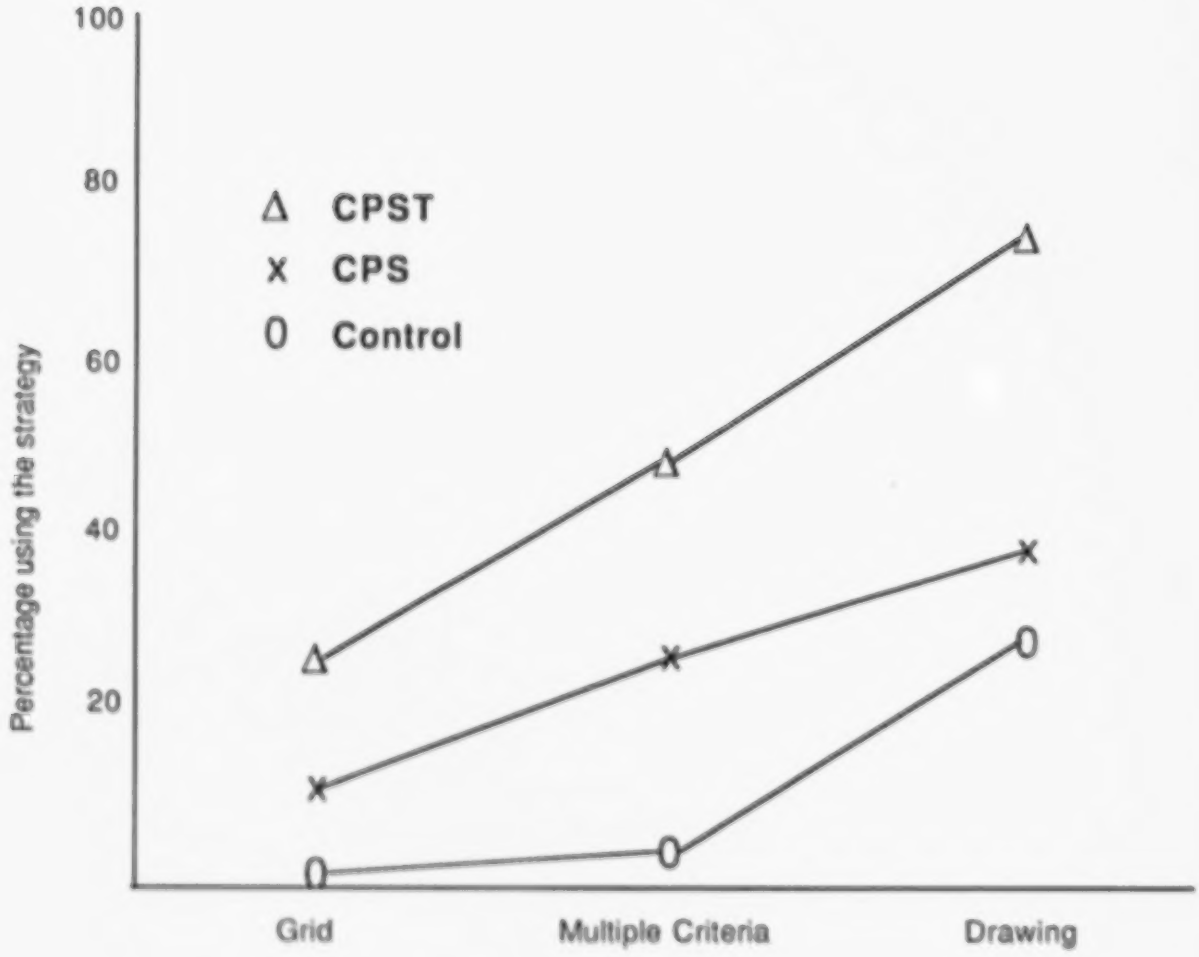

Table 1
Chi-square Contingency Table for Use of Criteria Grid

Group	Number Using (%)	Number Not Using (%)
Control	0 (0%)	26 (100%)
CPS	3 (11.5%)	23 (88.5%)
CPST	6 (26.1%)	17 (73.9%)

$X^2(2, N = 75) = 7.87, p < .05$; Cramer's V = .324

Table 2
Chi-square Contingency Table for Use of Multiple Criteria in Judging Solutions

Group	Number Using (%)	Number Not Using (%)
Control	1 (3.8%)	25 (96.2%)
CPS	7 (26.9%)	19 (73.1%)
CPST	11 (47.8%)	12 (52.2%)

$X^2(2, N = 75) = 12.53, p < .05$; Cramer's V = .378

Table 3
Chi-square Contingency Table for Use of Drawings

Group	Number Using (%)	Number Not Using (%)
Control	7 (26.9%)	19 (73.1%)
CPS	10 (38.5%)	16 (61.6%)
CPST	17 (73.9%)	6 (26.1%)

$X^2(2, N = 75) = 11.63, p < .05$; Cramer's V = .394